resulting average pressure is 29.84 for the whole globe, being 29.910 for the northern and 29.774 for the southern hemispheres respectively. If we increase these figures by 0.06, we shall make an approximate allowance for the diminution of gravity with altitude. On the other hand, there is a slight diminution of this computed mass, amounting to about one per cent, owing to the fact that we have assumed air to exist where the continents really are.

The problem, therefore, resolves itself into this. The average pressure to be used is about 29.90 inches, or 2.492 feet of mercury. A cubic foot of mercury weighs about 848 pounds, therefore, the weight of the atmosphere above any square foot of the earth's surface is 2,117 pounds. If we multiply this by the area of the globe in square feet, we get the total weight of the atmosphere. According to Woodward's Smithsonian Tables, page LXV, this area is 198,940,000 square miles, and each square mile is $5{,}280 \times 5{,}280$ square feet. The result is 10,392 followed by fifteen figures, or $10{,}392 \times 10^{15}$.

The mass of the atmosphere is therefore so small a fraction of that of the solid earth that it is represented by $\frac{1}{1125000}$ or about one one millionth.

The preceding value is the lower limit of the mass of the atmosphere. Our knowledge of the physical and mechanical conditions existing in the upper air is so unsettled at present that, according to Prof. R. S. Woodward, there is a possibility that there may be nearly 1,000 times as much air belonging to our atmosphere.

THE WEATHER BUREAU IN ALASKA.

The Chief of Bureau has issued orders transferring the central station of the Alaskan section of the Climate and Crop Service from Sitka to Eagle on the Yukon near the British line. Mr. H. L. Ball, the section director at Sitka, will return to the States, and the work in Alaska will be placed in the charge of Mr. U. G. Myers, who has been connected with the Weather Bureau for a number of years, and for the past twelve months has been in the region in which the new central station will be located. Owing to poor facilities for communication Mr. Ball found it impracticable to establish stations at interior points, and it is believed that by the change that has been ordered it will be possible to establish a number of stations in the upper Yukon region, from which it has been heretofore impossible to procure meteorological observations. The Bureau has already in its possession records covering several years of observations at Sitka, and also at other stations in the coast region, but at points far in the interior it has been almost wholly impossible to secure observations, although numerous efforts in that direction have been made. Mr. Myers' residence of the past twelve months in Alaska, and his determination to remain in that territory for some years to come, encourages the Chief of the Weather Bureau to believe that in the next few years most valuable information will be obtained concerning the climate of this region, of which so little is at present known. While the value of the observations at Eagle alone will amply justify the change that has been ordered, it is expected that Mr. Myers, with headquarters at Eagle, will be able to establish a number of voluntary stations at hitherto inaccessible places in the interior. Mr. Myers is a resolute and courageous young man, possessing mental and physical qualifications which especially fit him for the arduous duties and hardships involved in a residence in this inhospitable region. The station at Sitka will be maintained under Prof. C. C. Georgeson, who has charge of the agricultural experiment work in Alaska. Professor Georgeson will also have his assistants conduct meteorological observations at various points, at which they may be located in the prosecution of the experimental work under their charge.

SOLAR HALO.

Mr. James Hyatt, of Stanfordville, Duchess County, N. Y., reports a halo seen February 1, 1899, between 3 and 3:30 p. m., eastern standard time, consisting of an arc of prismatic colors, and convex to the sun, distant 46° from it and subtending an angle of about 50°. There were no other attending fragments of a halo and no parhelia.

It is rather rare that one observes this portion of a halo without any attending portions, but it is by no means unknown. The occurrence depends upon a rather rare combination of temperature and the altitude of the sun. This halo can only be formed when the sun's rays pass through crystalline needles of ice that are slowly descending through the atmosphere. The rays must enter the prism through faces or facets that are inclined to each other at an angle of 54° 44′. In higher latitudes, where halos frequently occur, the sun is generally so low down that a great variety of halo phenomena can be seen; but in these southern latitudes, when the ice needles are favorably located in the air, the sun is so high up that we see only the upper portion of the halo. On February 13, 1895, between 8:45 and 9:15 a. m., a similar phenomenon was seen at Washington, which is described and explained at page 56 of the MONTHLY WEATHER REVIEW for that date.

FREQUENCY OF INJURIOUS PHENOMENA.

A correspondent at Beaufort, S. C., says:

Why do we now have disastrous cyclones in this neighborhood about every two years, whereas twenty-five years ago they were of rare occurrence? And, again, why do we now have unusually severe cold spells, whereas formerly it was only at long intervals that orange trees were killed by cold snaps? Are not these changes due to the destruction of forests in the northwest?

The answers to these questions may interest many of our readers and are about as follows:

(*a*) The destruction of forests in "the northwest," no matter whether this term refers to the Appalachian Range or the Ohio Valley and Michigan, or Wisconsin and Lake Superior, or the Rocky Mountain region, or the Pacific Coast States, can not have had any appreciable influence upon the climate of the coast of South Carolina.

(*b*) An examination of the records that are available for study, during the past hundred years, shows that there has been no remarkable increase in the number of either cyclones or cold spells. The word "cyclone" is evidently used by our correspondent in the sense of an extensive storm, similar to the West Indian hurricanes, and not in the sense used in the Western States, where it has unfortunately been misapplied to the tornado.

(*c*) The atmosphere of the whole globe is everywhere subject to irregular variations, as well as to regular daily and annual variations in its temperature, moisture, winds, and storms. These irregular variations do not appear to depend directly upon anything outside of the air, such as the sun and moon above us, the changes produced by man on the surface of the earth below. They are as peculiar to and inherent in the atmosphere as the currents and ebullitions in a pot of boiling water or the eddies in a river during a flood are peculiar to those fluids. The cause and probable continuance of any unusual frequency of storms or frosts can not at present be definitely stated. If the records of these phenomena were precise and definite and extended over many years, for any given locality, we could calculate the probability that two or more would accidentally occur within a short period of time. Such computations have been made for other places, and have shown that there is no reason to think that a rare combination of years of disastrous meteorological phenomena will recur more than two or three times in a century.

In our inability to analyze the exceedingly complex interaction of the ocean and the land and the atmosphere, we ordinarily say that, so far as we are able to see, the occurrence of unusual combinations of weather is governed by the laws of chance. By this we simply mean that the laws of chance will tell us how many such combinations will occur in a century just as well as would the natural laws that we know must govern them. But the physical laws will give us the years and dates of the occurrence, whereas the mathematical laws of chance simply give us the statistical frequency of occurrence. Both these laws, however, will agree in showing that unusual combinations of events in one year will not be followed by similar combinations several times in rapid succession.

BAROGRAPHS ON SHIPS.

In the MONTHLY WEATHER REVIEW for December, 1898, p. 567, we have referred to the first barograph used by any ship on the Great Lakes. Concerning this important subject Mr. Norman B. Conger, local forecast official and marine agent, states that the article quoted by us from the Evening Herald of Duluth had first appeared on December 30 in the Detroit Journal, and was written by himself. The fact that it was forwarded to the Central Office by Mr. Richardson had led us to a misapprehension as to the authorship. Mr. Conger's article of December 30 seems to be of sufficient importance to justify its reproduction in full. What he says about the use of the barograph on the Great Lakes is equally true of the oceans. The barograph was introduced on ocean vessels twenty years ago as a means of obtaining continuous records for scientific study, but it was soon found that its practical value to the navigating officer was of even greater importance.

It appears that the original introduction of barographs was due to the suggestion of Mr. T. F. Townsend, in 1892, then inspector in the Weather Bureau, but now section director at Philadelphia. Captain Townsend interested Capt. James Martin, master of the steamer *Roanoke*, plying between Milwaukee and Grand Haven at that time. The purchase of a barograph by Captain Martin followed at once, and it was used by him until his death, several years later. The *J. D. Moran* was the first vessel to be supplied by the Weather Bureau.

The present state of the subject is shown in the following copy of Mr. Conger's article:

The United States Weather Bureau has met with all manner of discouragements in its efforts to introduce the barograph, or self-registering barometer, among the vessel masters of the Great Lakes. The first barograph used on the lakes was placed by the Bureau in the steamer *J. B. Moran* in 1892, but it was not until this season that the instrument was given a fair test.

When the marine work of the Bureau was resumed this season (1898) there were forty barographs placed by the Chief of the Bureau in the hands of masters of boats of representative firms on the lakes, so that each firm, as far as possible, would be presented with one barograph. All of them were distributed during the season and used by masters who took the records of each week and returned them to the Detroit office where duplicates were made. The original records were filed at Washington and the duplicates returned to the masters.

The record sheet gives practically a record of the vessel's course and weather while on her trip. It shows the actual condition of the air pressure for the entire period, the state of the weather, the force of the wind, and the location of the boat at noon each day are noted thereon daily by the masters, so that the sheets can be referred to at any time and the actual condition of the weather ascertained.

The prime object of placing the barographs on the Great Lakes in the hands of the masters was to educate them in the practical use of the barometer in connection with the daily weather map issued by the Bureau. When they get the weather map as they leave or pass some principal port, the masters observe where the storm centers are and the actions of their barographs inform them of the subsequent movements of the storm. So, whether lying in port or on the bosom of the lakes, with a careful study of the weather map and by watching the action of the barograph the master can keep fairly well informed of the progress of storms. These instruments show with great exactness and cacuracy the action of all squalls during the summer by decided and rapid fiuctuations.

During the season, masters who have had the use of these valuable instruments have said that they have received great benefit from watching the action of the barograph on their trips, and those placed on passenger steamers have saved the passengers many a hard shaking up, while they have enabled the freight steamers to make better time and with better weather.

The placing of the barographs on lake steamers was in a manner an experiment, as all vessels are supplied with the common aneroid barometer. Masters, in watching the actions of these instruments, do not get the benefit of the sudden changes which occur on the lakes, and are shown by the barograph, and for this reason many of the lake masters did not attach that importance to the use of barometers and the weather maps that they should.

A master, in leaving Buffalo for the upper lake ports, is in full communication with the Weather Bureau at least every twenty-four hours by receiving a weather map or a copy of the forecast, and it appears that there is no sufficient reason why the study of barometers should not be more general in connection with the navigation of boats. During the summer season there is probably not so much necessity of a careful scrutiny of the barograph as during that period in which the weather is more settled, and the storms, a few local squalls, are practically all that may be anticipated, and these are surely foretold by the barograph. During the fall, when the stormy season begins, a close attention to the weather map and action of the barometer will give much better results than could be anticipated from taking the weather as it comes without any foreknowledge of its intensity.

Of the 40 masters who used the barograph during the season, only three have said that its use was not of sufficient importance to them to be further desired, but two of these have since said that they would be glad to retain the instrument if it was desired by the Bureau.

The care required by the instrument is very slight, simply to change the record sheet once a week and wind up the clock, to record each day the state of the weather, the force of the wind, and the location of the vessel at noon. These record sheets are valuable for study, both to the master and the Bureau, and there is no doubt but that the Chief of the Bureau would be pleased to furnish all masters who have barographs on their vessels with the necessary record sheets in order that this valuable data may be placed within the reach of the Chief for the study of marine work on the lakes.

The one valuable feature of the barograph over the common aneroid barometer is that the barograph tells the story of the rise and fall of the pressure of the air at all times, so that should the master be absent from his cabin for some time and then return, the barograph informs him immediately of what action has taken place in the weather during his absence. The common aneroid does not make a record of these changes, and, in consequence, the master loses information which might be very valuable to him.

It is thought that with the intelligent use of the barograph in connection with the information which is freely furnished by the Weather Bureau, there will be a lessening of the number of disasters which occur through weather conditions, and, therefore, a material decrease in the losses of vessel property.

Many masters refused the aid of the barograph because they were not "fair weather sailors." They said that their boats were built to withstand all the storms that occur, and that they were expected to force their boats along through fair weather and foul. The weather men met them with the argument that they were not expected to run for shelter every time that the barograph indicated a blow. By studying the barograph and the weather maps the master becomes his own weather prophet. The maps show the storm tracks, so he is enabled to arrive at the direction and velocity of the approaching storm. This gives the master a chance to choose his course so as to dodge the worst of the gale.

WHY DO BIRDS MIGRATE?

It is commonly thought that birds migrate because of the changes in the weather; that they seek in winter a warmer and in summer a cooler climate, so as to avoid being subjected to great vicissitudes of temperature. But naturalists tell us that the migrations are largely a matter of the search after food. They leave a given region because a specific food is exhausted, and they fly to another specific region because the experiences of the tribe as a whole have shown that desirable food can be found there. They are driven by hunger out of one place and are led by experience to another. It is not the winds that drive them, nor is it the temperature that tempts them.